

### Resource Flexibility

The growth of intermittent renewable generation to meet California's 33 percent Renewables Portfolio Standard (RPS) by 2020 has spurred several studies to determine the extent to which the system operator needs additional flexible capabilities.<sup>1</sup> Furthermore, because of expected changes in the natural gas-fired dispatchable fleet, the California Independent System Operator (California ISO) is concerned that it needs greater operational control over flexible capacity than is available through California Public Utilities Commission (CPUC) rules or California ISO tariffs.

#### Flexibility Requirements

Models used to match large amounts of renewable resources with firming resources, resources that can be used to compensate for the intermittency of renewables, have traditionally used a standard one-hour time resolution. Operational concerns in the California electrical system, however, are increasingly focused on much shorter time scales. For example, there may be plenty of reserve generation capacity, but a lack of fast-responding resources that can follow a rapid change in generation and load. Thus, key characteristics of firming resources include not only total capacity, but also response times and ramp rates (e.g., megawatts per minute).<sup>2</sup>

Analyses to date suggest that flexible capacity has to address variability in load and power production in three time scales: (1) seconds-to-minutes, (2) 5-10 minutes, and (3) multihour. Variations in the seconds-to-minutes time scale can be addressed through expanding the existing regulation service, largely using automatic generation control on existing generators. The 5-10-minute flexibility requirements address discrepancies between the 5-minute real-time market schedules and actual loads or generation encountered during these intervals. Improved forecasting is likely to be the best approach for addressing this issue. Multihour ramps up and down have been a feature of California's electrical system for decades, but the introduction of large amounts of renewable capacity with strong diurnal cycles exacerbates these traditional patterns and is the focus of flexible capacity efforts.

The California ISO popularized a graphical depiction of the net load curve (the "duck chart") that dispatchable generating resources must satisfy. **Figure 1** (prepared by California Energy Commission staff replicating the process developed by the California ISO) illustrates the extent to which nonintermittent resources must be available to ramp up or down to satisfy the "net load" curve.<sup>3</sup> A net load curve shares many features with a total load curve but superimposes the hour-by-hour variability of wind and solar generation. Distinctions between the shape of the total load curve and the net load curve are exacerbated as intermittent generating capacity

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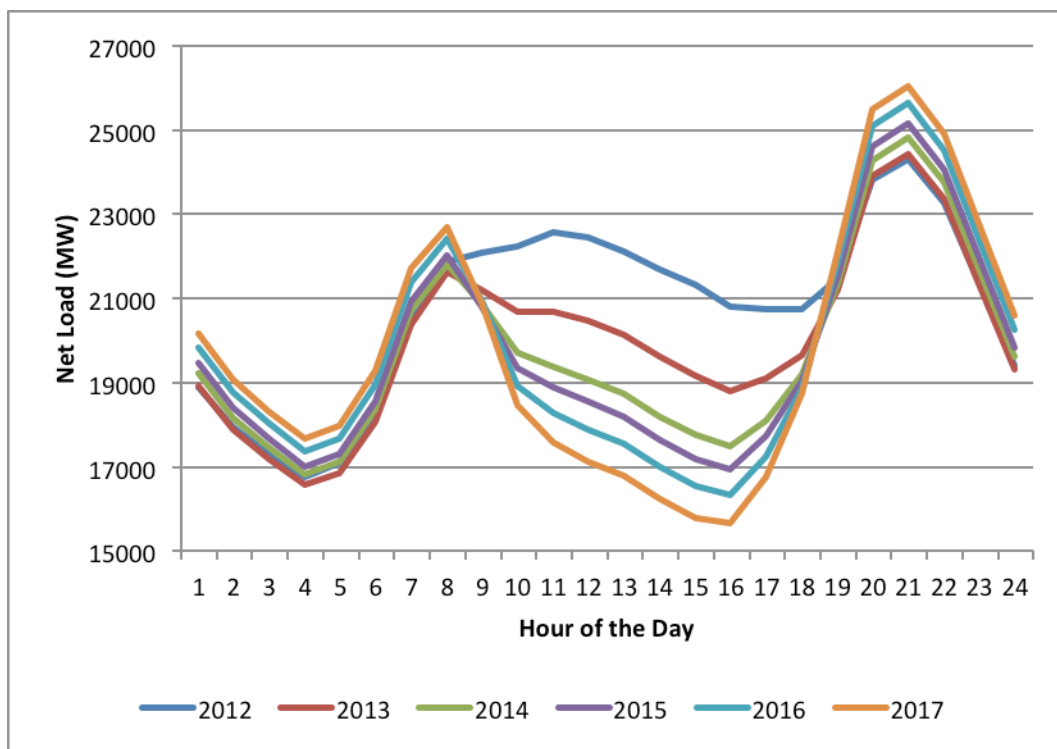
1 <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M064/K141/64141005.PDF>.

2 Alexandra von Meier. California Institute for Energy and Environment, *Integration of Renewable Generation in California, Coordination Challenges in Time and Space*, 2011, <http://uc-ciee.org/electric-grid/4/557/102/nested>

3 By definition, a *net load curve* is the hourly total load less the hourly production of wind and solar generating facilities.

increases to satisfy the 33 percent by 2020 RPS mandate. **Figure 1** uses actual California ISO system data from March 22, 2013, to illustrate the point. The net load curve labeled 2013 is the actual data from the California ISO Renewables Watch website.<sup>4</sup> (The net load curves for years 2014-2017 use the same load, wind, and solar shapes as were actually experienced on March 22, 2013, but scaled up using load forecasts prepared by the Energy Commission and projected increases in intermittent capacity expected to come on-line in future years.) The need to pay attention to flexible capacity stems from the large increase in the late afternoon ramp up and, to a lesser extent, the increase in the midmorning ramp down. Although there is much variation in the specific shapes of the net load curve from one day to another within a month, there is little doubt that this pattern is occurring. **Figure 1** suggests that the late afternoon up ramp will be nearly twice as large by 2017 as it was in 2012 for the conditions of this day and with the expected resource mix into the future. However, there is considerable uncertainty in forecasting hourly load profiles and intermittent resource profiles years into the future, and so the analysis illustrates an issue that planners must address, but the precise results are uncertain, particularly for the out years.

**Figure 1: Illustrative Change in Net Load Curve Using  
Load Shapes and Production Profiles from 3/22/2013**



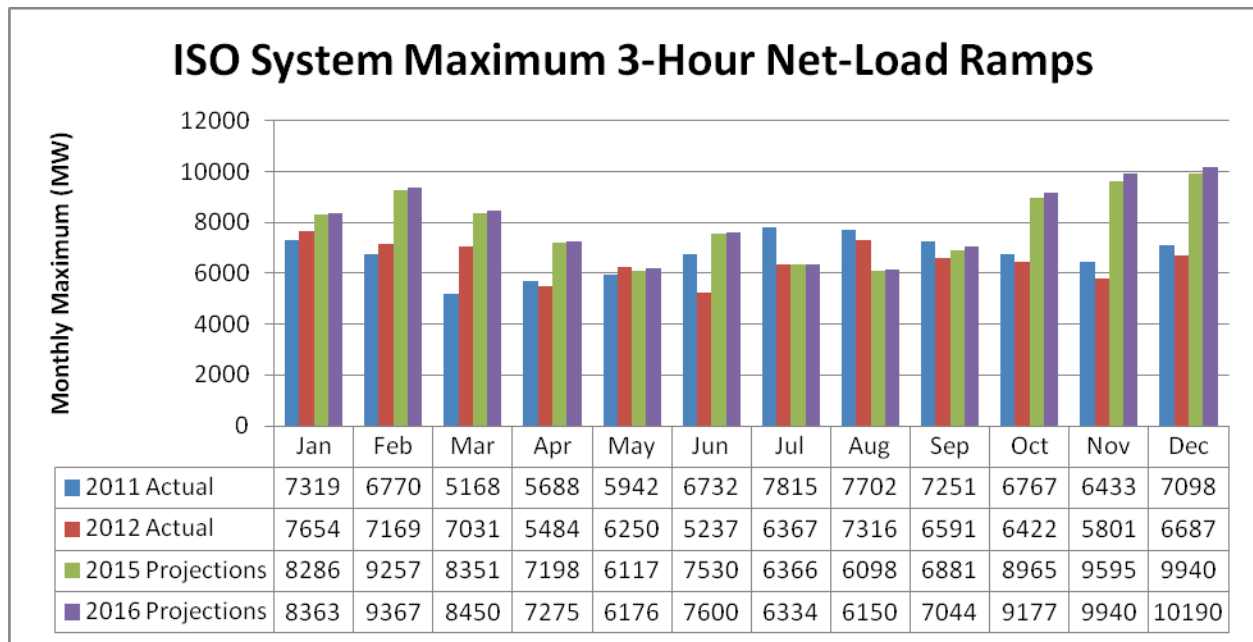
<sup>4</sup> <http://www.caiso.com/green/renewableswatch.html>.

Source: California Energy Commission, Electricity Supply and Analysis Division (ESAD)

Analyses of loads and generation profiles throughout the year show that the problem of rapidly increasing net load ramps is most severe in the winter months of November through March.

**Figure 2** provides an estimate of the maximum 3-hour ramp by month for two historical years and two projection years based on renewable projects now in the pipeline. **Figure 2** shows that maximum monthly 3-hour ramps are relatively uniform throughout the year historically and become much larger into the future for the five winter months. The implication is the need for flexible resources to satisfy this increasing ramp for the winter months, opposite of the traditional capacity planning focus on summer peak months of July to September.

**Figure 2: Comparing Historical and Projected Maximum 3-hour Ramps by Month**



Source: California ISO, *Final 2014 Flexible Capacity Needs Assessment*, Figure 1, page 7, May 1, 2014 submitted into CPUC Resource Adequacy proceeding. [http://www.caiso.com/Documents/Final\\_2014\\_FlexCapacityNeedsAssessment.pdf](http://www.caiso.com/Documents/Final_2014_FlexCapacityNeedsAssessment.pdf)

### Flexible Resources

Since the current California ISO assessments assume that renewable resources will continue to be “must take,” the California ISO wants to ensure that sufficient flexible capacity will be available to satisfy these growing ramping requirements. The electricity planning processes among the CPUC, California ISO, and Energy Commission have not yet considered the use of renewable curtailment as a mechanism to improve the integration issues discussed above. The

California ISO has proposed,<sup>5</sup> and the CPUC has accepted,<sup>6</sup> a definition of effective flexible capacity (EFC) for each generating facility that accounts for its start-up time, ramping ability over three hours, minimum generation level, and net qualifying capacity. **Table 1** assesses the aggregate amount of EFC by generating technology and fuel type.<sup>7</sup> Clearly, the total of more than 31,800 megawatts (MW) of existing flexible capacity expected in 2014 exceeds the largest California ISO estimate of requirements in 2016. However, there are three concerns suggesting that the balance between requirements and capabilities is tighter than it might appear in comparing **Figure 2** with **Table 1**.

First, nearly all of the steam turbine capacity is very old, and most of it uses once-through cooling (OTC) technology. Facility owners must satisfy State Water Resource Control Board (SWRCB) OTC policy by retiring or retrofitting the power plants. (For more information, see the Tracking Progress on [Once-Through Cooling](#).) Generator intentions submitted to the SWRCB in response to information requests reveal that most generator owners plan to comply by retiring, although many would prefer to repower if long-term contracts can be secured from load-serving entities (LSEs). Retiring old steam boiler capacity reduces the flexible fleet capability to about 22,000 MW.

**Table 1: Effective Flexible Capacity by Generating Technology and Fuel Type (Megawatts)**

Generating Technology	Natural Gas	Geothermal	Water	Landfill	Wood Waste	Petroleum Coke	All Fuels
Steam turbines	10,067	488	0	22	0	0	10,577
Combined cycle	9,134	0	0	0	0	0	9,134
Peaker	48	0	0	0	0	0	48
Combustion turbine	6,723	0	0	0	0	0	6,723
Reciprocating engine	255	0	0	17	0	0	272
Internal combustion	0	0	0	3	0	0	3
Hydroelectric	0	0	3,803	0	0	0	3,803
Pumped storage	0	0	1,212	0	0	0	1,212
Other/aggregations	70	0	0	0	0	0	70
All Technologies	26,296	488	5,015	42	0	0	31,841

Source: California Energy Commission/ESAD analysis of California ISO data (Final 2014 EFC list, October 2013)

Second, much of the fossil-fired generating fleet must shut down for annual maintenance, and the optimal time has typically been in the winter months, when loads have been low. The need for much larger amounts of flexible capacity in winter months means that there are now competing motivations for when to schedule maintenance: (1) avoid winter months to make

<sup>5</sup> <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M064/K141/64141005.PDF>, slide 18.

<sup>6</sup> <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M070/K423/70423172.PDF>.

<sup>7</sup> <http://www.caiso.com/Documents/EffectiveFlexibleCapacityReport.xls>.

capacity available for flexibility requirements, versus (2) continue maintenance in off-peak and nonhydroelectric runoff months when it is not needed for basic capacity.

Third, even if flexible capacity exists, the California ISO intends to establish new requirements that would provide greater control over the use of this capacity. The California ISO markets have traditionally featured a large amount of self-scheduling.<sup>8</sup> For example, LSEs, through their scheduling coordinator, choose when to generate to serve their load. For capacity that is nominated to satisfy current resource adequacy requirements, the generating capacity must be available to the California ISO if it is not self-scheduled. If it is self-scheduled, then the resource adequacy obligation is satisfied. However, for flexible capacity that must be responsive to intermittent wind and solar generation, the California ISO wants to have greater control to ensure that it can dispatch capacity up or down to satisfy net loads. LSE/generator contracts with self-scheduling will still be allowed, but such capacity will not count as flexible. An LSE wishing to continue to self-schedule will be required to satisfy its share of the aggregate flexible capacity requirements by nominating<sup>9</sup> other capacity that is both physically flexible and can be dispatched up or down by the California ISO.

### *Balancing Requirements With Expected Capabilities*

In Decision (D.)13-06-024, the CPUC determined that it would implement, beginning with compliance year 2015, the general approach of imposing an effective flexible capacity requirement proposed by the California ISO.<sup>10</sup> Numerous implementation questions were resolved in D.14-06-050, perhaps only on an interim basis, to implement a mandatory obligation for calendar year 2015.<sup>11</sup>

The evolution of flexibility requirements satisfactory to both the CPUC and California ISO has resulted in mechanisms to allow use limited resources to satisfy a portion of the flexibility requirements. In D.14-06-050, the CPUC established the following three categories on an interim basis:

- Category 1: Base Flexibility (must offer from 5 a.m. to 10 p.m. daily, year round)
- Category 2: Peak Flexibility (must offer 5 hours per day defined seasonally with at least one start per day)

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<sup>8</sup> While generation owners can specify the price(s) at which the California ISO can induce changes in the amount of energy or ancillary services they provide, a self-scheduled generation resource does not specify such a price or prices, effectively precluding the California ISO from changing the amount provided. For example, utilities – load-serving entities that own generation – will frequently self-schedule their own generation to satisfy their load and ancillary service requirements, thereby reducing the amount of capacity that the California ISO can (re)dispatch to meet operational needs.

<sup>9</sup> To “nominate” capacity means to submit a proposed schedule and price points to the California ISO scheduling process and to accept the results of the California ISO’s market optimization process.

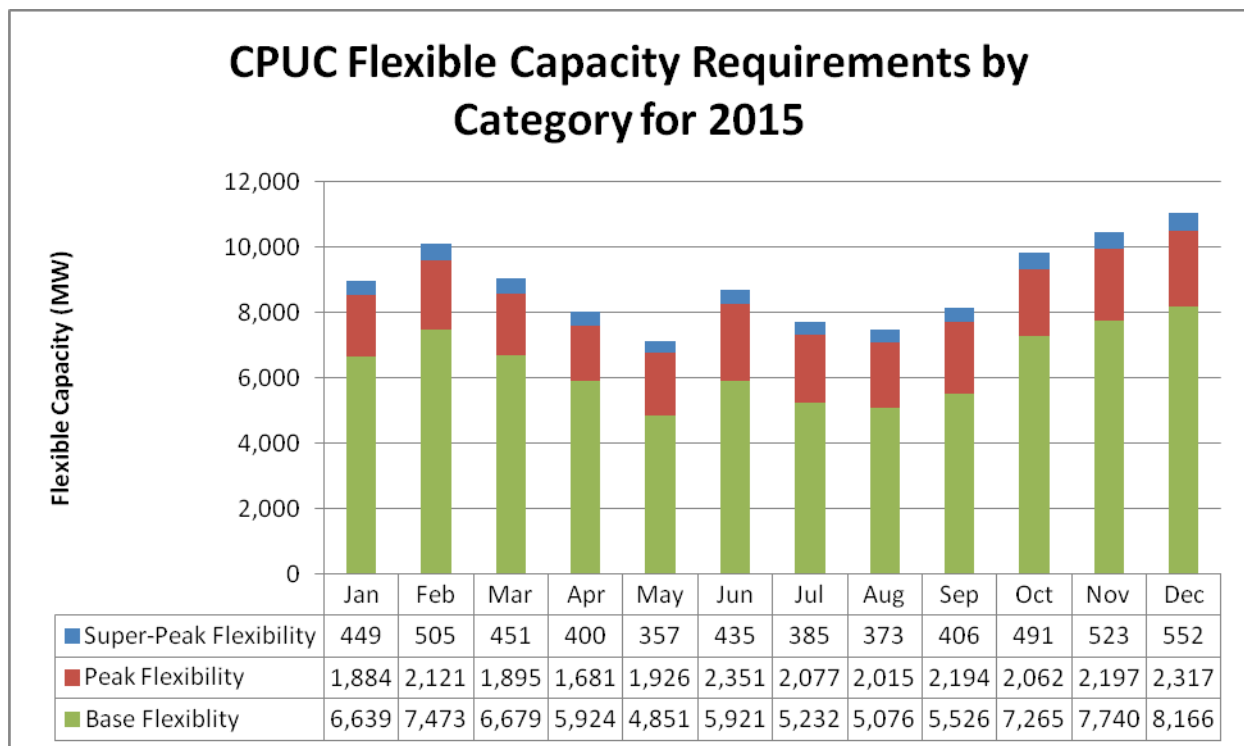
<sup>10</sup> D.13-06-024, <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M070/K423/70423172.PDF>.

<sup>11</sup> <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M097/K619/97619935.PDF>

- Category 3: Super-Peak Flexibility (must offer 5 hours per day defined seasonally, with obligation complete after five starts per month)

**Figure 3** provides a graphical representation of how the three categories proposed by the California ISO could be used to satisfy the overall requirements for CPUC-jurisdictional LSEs. The numeric limit for Categories 2 and 3 is a maximum, while the limit for Category 1 is a minimum. In effect, peak and super-peak resources are allowed to be chosen up to specified monthly limits, while Category 1 can be used as much as the LSE desires. Each LSE can establish its own preferred combination guided by these aggregate limits.

**Figure 3: Monthly Flexible Capacity Limits by Resource Category for CPUC Jurisdictional Entities**



Source: "Cal ISO Submission of Addendum to Final 2014 Flexible Capacity Needs Assessment," May 5, 2014 in R.11-10-023.

Assessing expected future capabilities versus requirements, taking into account generating resource development in the pipeline, generating resource retirements due to age or regulatory mandates like the OTC policy, examining changes in load levels and load shapes, and considering renewable curtailment are necessary to determine whether there is a need for additional flexible capacity. The CPUC has attempted to develop a long-term assessment by working with the California ISO in the 2010 and 2012 Long Term Procurement Plan (LTPP) rulemakings. California ISO studies have developed 10-year forward estimates of need for upward ramping capacity ranging from 0 – 4,600 MW, depending upon the iteration of the model

and input assumptions.<sup>12</sup> The CPUC has concluded this range is too uncertain to justify procurement.<sup>13</sup> Another round of analyses to identify long-term flexibility needs is now actively underway in the 2014 LTPP rulemaking.<sup>14</sup> To determine when new resource additions, if any, will be required, a transition needs to be developed between the short-term mechanism for meeting flexibility needs (as adopted in the resource adequacy program by D.14-06-050) and the long-term approach being investigated in 2014 LTPP.

### Additional References:

Energy Commission, *Challenges to the Integration of Renewable Resources at High System Penetration*, CEC-500-2014-042, May 2014.

Lazar, Jim, *Teaching the “Duck” to Fly*, Regulatory Assistance Project, January 2014.

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### Next Update:

July 2015 with updates provided annually

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<sup>12</sup> [http://www.energy.ca.gov/2013\\_energy\\_policy/documents/2013-07-15\\_workshop/background/Summary\\_of\\_Studies\\_of\\_Southern\\_California\\_Infrastructure.pdf](http://www.energy.ca.gov/2013_energy_policy/documents/2013-07-15_workshop/background/Summary_of_Studies_of_Southern_California_Infrastructure.pdf), Table 2.

<sup>13</sup> <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M076/K995/76995686.PDF>.

<sup>14</sup> <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M090/K548/90548289.PDF>.